

RTCA Special Committee 209, Working Group #1

Mode S Transponder MOPS Maintenance

Meeting #4

RTCA, Washington DC

4 – 6 December 2007

**Detailing The Proposed Changes to Figures in
Order to Harmonize DO-181D and ED-73C**

**(This version was created after WG-1 Meeting #3 to add some Figures and clarifications before
sending to WG-49 for their November meeting)**

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SUMMARY

This Working Paper builds from the beginning of the comparison of the differences between Figures in both DO-181D and ED-73C in Working Papers SC209-WP07-09 which was briefly discussed in Brussels in August, and ModeS-WP03-04R1 from Meeting #3 of WG-1 in Washington in October. This Working Paper attempts to give more specifics that can be reviewed and agreed upon so that we can move forward toward having a single set of Visio files for the Figures in both documents. This Working Paper was available to WG-49 during their November meeting in Cologne, but they did not review it. WG-49 is set to review this document during their meeting in Paris during the same days of this SC-209 WG-1 Meeting #4.

Table of Figures in DO-181D and ED-73C

DO-181D Figures	DO-181D Titles	ED-73C Figures	ED-73C Titles	Status
Figure 2-01	General Pulse Pattern for PAM Interrogations	Figure 1-1	General Pulse Pattern for PAM Interrogations	Identical
Figure 2-02	General Pulse Patterns for DPSK Interrogations	Figure 1-2	DPSK Pulse Characteristics	Differences Acceptable
		Figure 3-1	Spectrum Limits for Mode S Transponder Transmitter	
Figure 2-03	Mode S Reply Waveform	Figure 3-2	Mode S Reply Waveform	Identical
Figure 2-04	Overview of Mode S Interrogation (Uplink) Formats	Figure 3-3	Overview of Mode S Interrogation (Uplink) Formats	ED-73 needs updating
Figure 2-05	Overview of Mode S Reply (Downlink) Formats	Figure 3-4	Overview of Mode S Reply (Downlink) Formats	ED-73 needs updating
Figure 2-06	Field Index	Figure 3-5A	Field Index (Uplink)	ED-73 needs updating
		Figure 3-5B	Field Index (Downlink)	ED-73 needs updating
Figure 2-07	Level 1 Transponder Uplink Formats	Figure 3-6	Level 1 Transponder Uplink Formats	Same content, different format
Figure 2-08	Level 1 Transponder Downlink Formats	Figure 3-7	Level 1 Transponder Downlink Formats	Same content, different format
Figure 2-09	Functional Diagram of Uplink Coding	Figure 3-8	Functional Diagram of Uplink Coding	Identical
Figure 2-10	Functional Diagram of Downlink Coding	Figure 3-9	Functional Diagram of Downlink Coding	Identical
Figure 2-11	The Level 1 Transponder: Interrogation Acceptance	Figure 3-10	The Level 1 Transponder: Interrogation Acceptance	Figure 2-11 updated to match Figure 3-10 for SI protocol
Figure 2-12	All Transponders: Lockout Initiation	Figure 3-11	All Transponders Lockout Initiation	Figure 2-12 updated to match Figure 3-11 for SIS=0
Figure 2-13	All Transponders: FS and VS Protocol	Figure 3-12	Flight Status and Vertical Status Protocols	Figure 3-12 is missing a “YES” under the “A” box
Figure 2-14	All Transponders: Reply Content	Figure 3-13	Reply Content	Figure 2-14 updated to match Figure 3-13
Figure 2-15	All Level 2 Transponders: Formats	Figure 3-14	Transponder Formats for Level 2 Transponder	Same content, different format
Figure 2-16	Data Link Transponders Interrogation Acceptance	Figure 3-15	Data Link Transponders Interrogation Acceptance	Figure 2-16 updated to match Figure 3-15 for SI protocol
Figure 2-17	All Level 2 Transponders Coordination	Figure 3-16	All Data Link Transponders: Coordination	Identical
Figure 2-18	All Level 2 Transponders UM Protocol	Figure 3-17	UM Protocol	“T _{RS} Timer Runs” in Fig 3-17 incorrect, should be T _{RB}
Figure 2-19	All Data Link Transponders B Protocol	Figure 3-18	Data Link Transponders: B-Protocol	Differences to be discussed
		Figure 3-18A	Enhanced Comm-B Protocol	
Figure 2-20	Comm-C Reservation and Closeout	Figure 3-19	Comm-C Reservation and Close Out	Identical
		Figure 3-19A	Enhanced Comm-C Reservation and Close Out	
Figure 2-21	Comm-C Message Handling	Figure 3-20	Comm-C Message Handling	We believe that Figure 3-20 should be replaced with Figure 2-21

DO-181D Figures	DO-181D Titles	ED-73C Figures	ED-73C Titles	Status
		Figure 3-20A	Enhanced Comm-C Message Handling	Should be carefully reviewed in light of the differences with Figure 2-21
Figure 2-22	Comm-D Reservation and Closeout	Figure 3-21	Comm-D Reservation and Closeout	Identical
		Figure 3-21A	Enhanced Comm-D Reservation and Closeout	
Figure 2-23	Comm-D Message Handling	Figure 3-22	Comm-D Message Handling	Figure 3-22 error in decision box E with Yes/No reversed
		Figure 3-22A	Enhanced Comm-D Message Handling	
Figure 2-24		Figure 5-1	Test Equipment Connection	Fig 5-1 matches Fig 2-24
Figure 2-25		Figure 5-2	Test Equipment Connection	Fig 5-2 matches Fig 2-25
Figure 2-26		Figure 5-3	Test Equipment Connection	Fig 5-3 matches Fig 2-26
Figure 2-27		Figure 5-5	Test Equipment Connection	Fig 5-5 matches Fig 2-27
Figure 2-28	(not referenced in DO-181C or D)			
Figure 2-29		Figure 5-6	Test Equipment Connection	Fig 5-6 matches Fig 2-29
Figure 2-30		Figure 5-7	Test Equipment Connection	Fig 5-7 matches Fig 2-30
Figure 2-31		Figure 5-8	Test Equipment Connection	Fig 5-8 matches Fig 2-31
Figure 2-32		Figure 5-4	Test Equipment Connection	Fig 5-4 matches Fig 2-32

Specific Details Regarding Differences in Figures:

- Figure 3-3 in ED-73C needs to be updated by revising UF=19 as agreed to during Brussels meeting, and UF=22 as required by SARPs CP. Proposed changes shown in **yellow**.

Format #	UF								
0	0 0000	- 3 -	RL: 1	- 4 -	AQ: 1	DS: 8	- 10 -	AP: 24	... Short Air-Air Surveillance (ACAS)
1	0 0001							AP: 24	
2	0 0010							AP: 24	
3	0 0011							AP: 24	
4	0 0100	PC: 3	RR: 5	DI: 3	SD: 16			AP: 24	... Surveillance, Altitude Request
5	0 0101	PC: 3	RR: 5	DI: 3	SD: 16			AP: 24	... Surveillance, Identity Request
6	0 0110							AP: 24	
7	0 0111							AP: 24	
8	0 1000							AP: 24	
9	0 1001							AP: 24	
10	0 1010							AP: 24	
11	0 1011	PR: 4	IC: 4	CL: 3			- 16 -	AP: 24	... Mode S-Only All-Call
12	0 1100							AP: 24	
13	0 1101							AP: 24	
14	0 1110							AP: 24	
15	0 1111							AP: 24	
16	1 0000	- 3 -	RL: 1	- 4 -	AQ: 1		- 18 -	MU: 56	AP: 24 ... Long Air-Air Surveillance (TCAS)
17	1 0001							AP: 24	
18	1 0010							AP: 24	
19	1 0011	AF: 3							... Military Application
20	1 0100	PC: 3	RR: 5	DI: 3	SD: 16	MA: 56		AP: 24	... Comm-A, Altitude Request
21	1 0101	PC: 3	RR: 5	DI: 3	SD: 16	MA: 56		AP: 24	... Comm-A, Identity Request
22	1 0110							AP: 24	... Reserved for Military Use
23	1 0111							AP: 24	
24	1 1xxx	RC: 2		NC: 4		MC: 80		AP: 24	... Comm-C (ELM)

Figure 3-3: Overview of Mode S Interrogation (Uplink) Formats

2. Figure 3-4 in ED-73C needs to be updated by revising DF=19 as agreed to during Brussels meeting, and UF=22 as required by SARPs CP. Proposed changes shown in yellow.

Format #	DF										
0	0 0000	VS: 1	CC: 1	-1-	SL: 3	-2-	RI: 4	-2-	AC: 13	AP: 24	... Short Air-Air Surveillance (ACAS)
1	0 0001				27 or 83					P: 24	
2	0 0010				27 or 83					P: 24	
3	0 0011				27 or 83					P: 24	
4	0 0100	FS: 3	DR: 5	UM: 6	AC: 13	AP: 24					... Surveillance, Altitude Reply
5	0 0101	FS: 3	DR: 5	UM: 6	ID: 13	AP: 24					... Surveillance, Identity Reply
6	0 0110				27 or 83					P: 24	
7	0 0111				27 or 83					P: 24	
8	0 1000				27 or 83					P: 24	
9	0 1001				27 or 83					P: 24	
10	0 1010				27 or 83					P: 24	
11	0 1011	CA: 3	AA: 24	PI: 24							... All-Call Reply
12	0 1100				27 or 83					P: 24	
13	0 1101				27 or 83					P: 24	
14	0 1110				27 or 83					P: 24	
15	0 1111				27 or 83					P: 24	
16	1 0000	VS: 1	-2-	SL: 3	-2-	RI: 4	-2-	AC: 13	MV: 56	AP: 24	... Long Air-Air Surveillance (TCAS)
17	1 0001	CA: 3	AA: 24	ME: 56	AP: 24						... Extended Squitter
18	1 0010	CF: 3	AA: 24	ME: 56	AP: 24						... Extended Squitter / Non-Transponder
19	1 0011	AF: 3	Military Application :104								... Military Application
20	1 0100	FS: 3	DR: 5	UM: 6	AC: 13	MB: 56	AP: 24				... Comm-B, Altitude Reply
21	1 0101	FS: 3	DR: 5	UM: 6	ID: 16	MB: 56	AP: 24				... Comm-B, Identity Reply
22	1 0110				27 or 83					P: 24	... Reserved for Military Use
23	1 0111				27 or 83					P: 24	
24	1 1xxx	-1-	KE: 1	ND: 4	MD: 80	AP: 24					... Comm-D (ELM)

Figure 3-4: Overview of Mode S Reply (Downlink) Formats

3. Figures 3-5A and 3-5B in ED-73C for Uplink and Downlink Fields need to be updated by adding entries for AF, CF, II and SI codes, as appropriate.

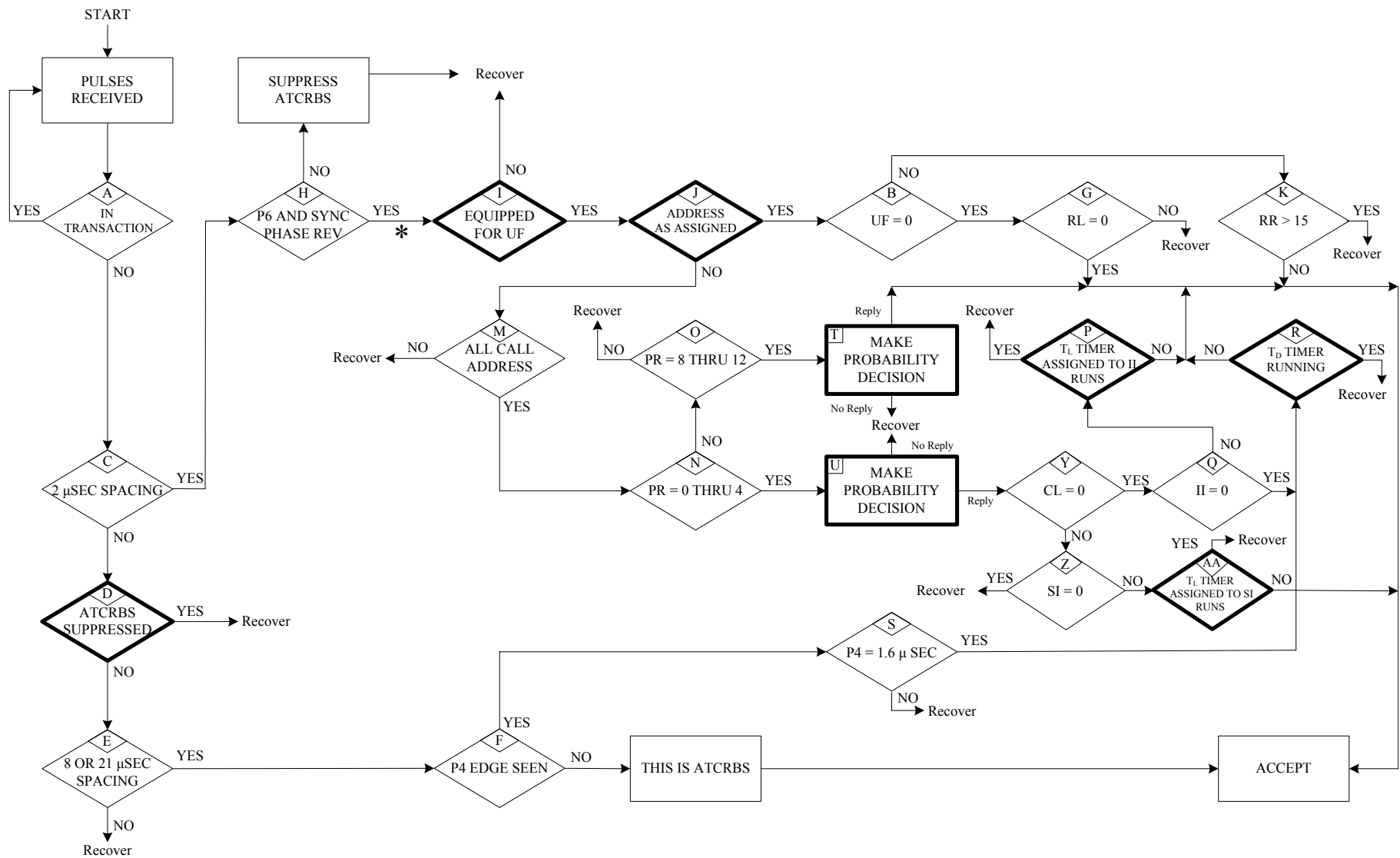


Figure 2-11R1: WITH CHANGES PROPOSED TO HARMONIZE WITH ED-73C Figure 3-10 for SI Protocol

Specific Details Regarding Differences in Figures (Continued):

5. Figure 2-12(A) in DO-181D differed from Figure 3-11 in ED-73C because it appears that Figure 3-11 had a decision box for SIS=0 and Figure 2-12(A) had not been updated. Therefore Figure 2-12(A) is shown below as the original, and Figure 2-12(A)R1 is shown as modified to account for the addition of the blocks for SIS=0.

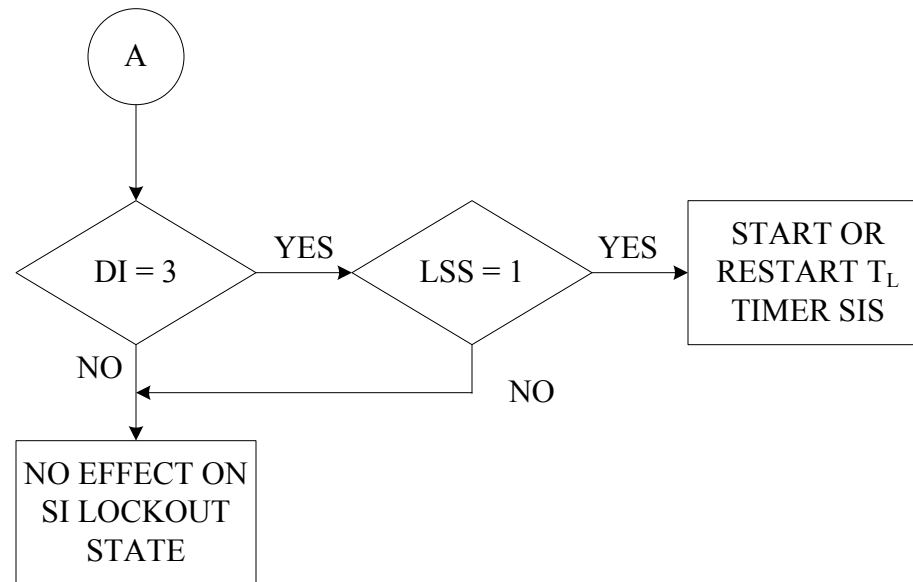


Figure 2-12(A): ORIGINAL FROM DO-181D, v1.1

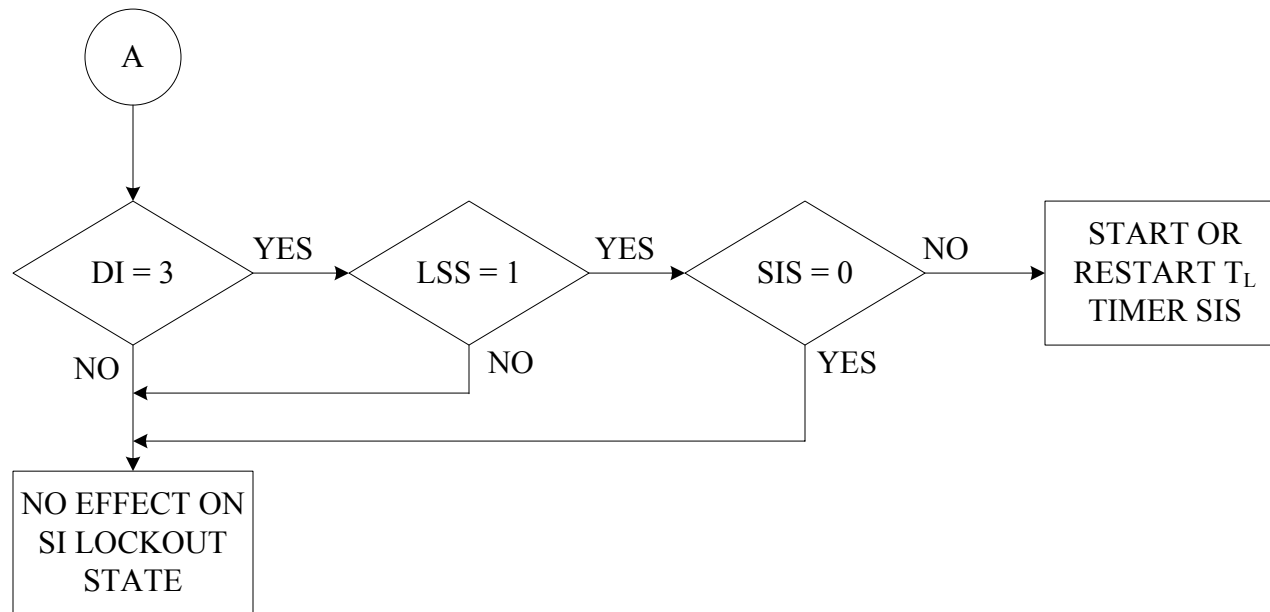


Figure 2-12(A)R1: WITH CHANGES PROPOSED TO HARMONIZE WITH ED-73C Figure 3-11 for SIS=0

Specific Details Regarding Differences in Figures (Continued):

6. Figure 3-12 in ED-73C is missing a “YES” decision on the right side of the figure coming out of the “A” box. With the addition of the “YES” decision in ED-73C, Figure 3-12, it is then identical with DO-181D, Figure 2-13.

7. After analysis it appears that Figure 2-14 in DO-181D has several errors, and that Figure 3-13 in ED-73C is correct. Therefore, Figure 2-14R1 is proposed to be updated to match Figure 3-13 as shown below.

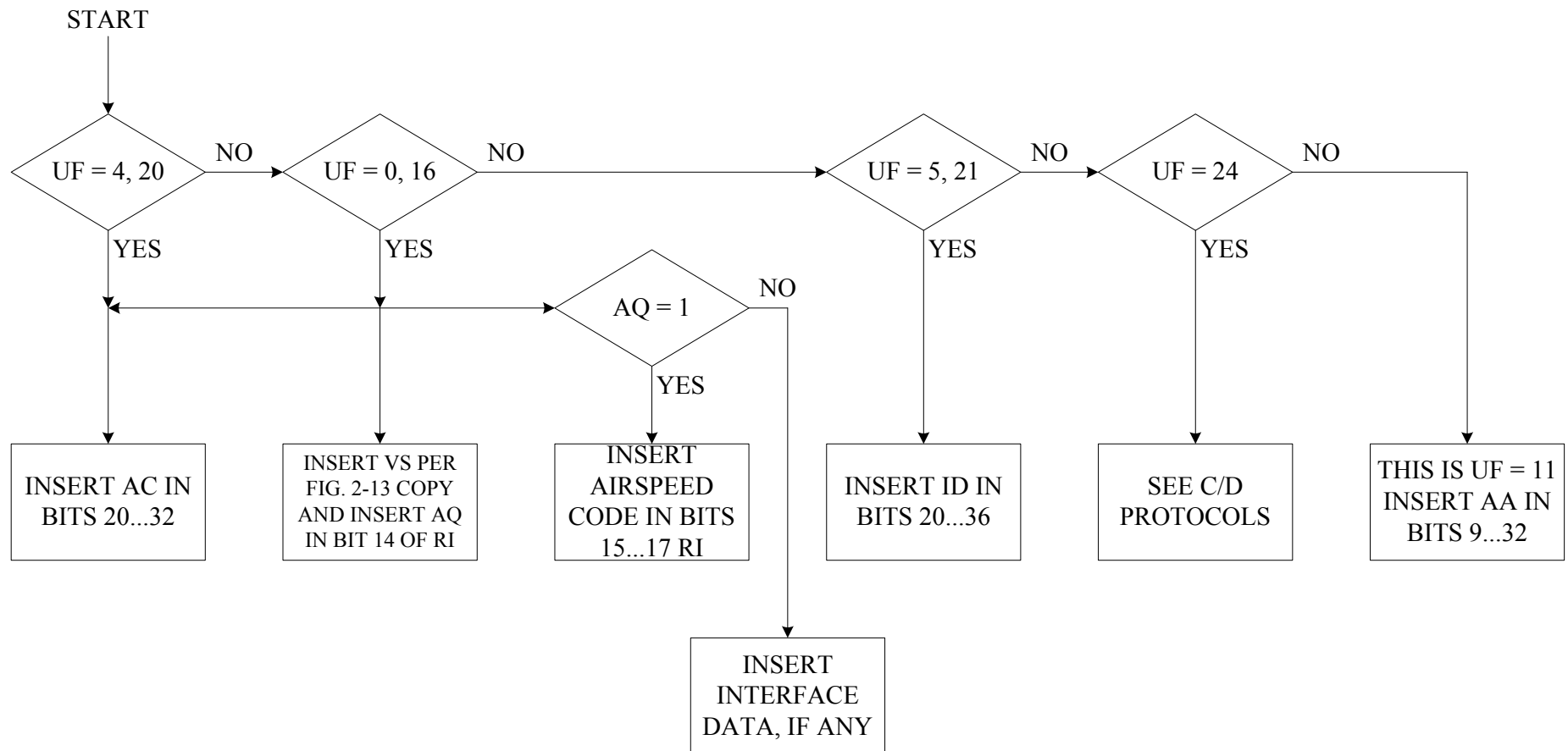


Figure 2-14: ORIGINAL FROM DO-181D, v1.1

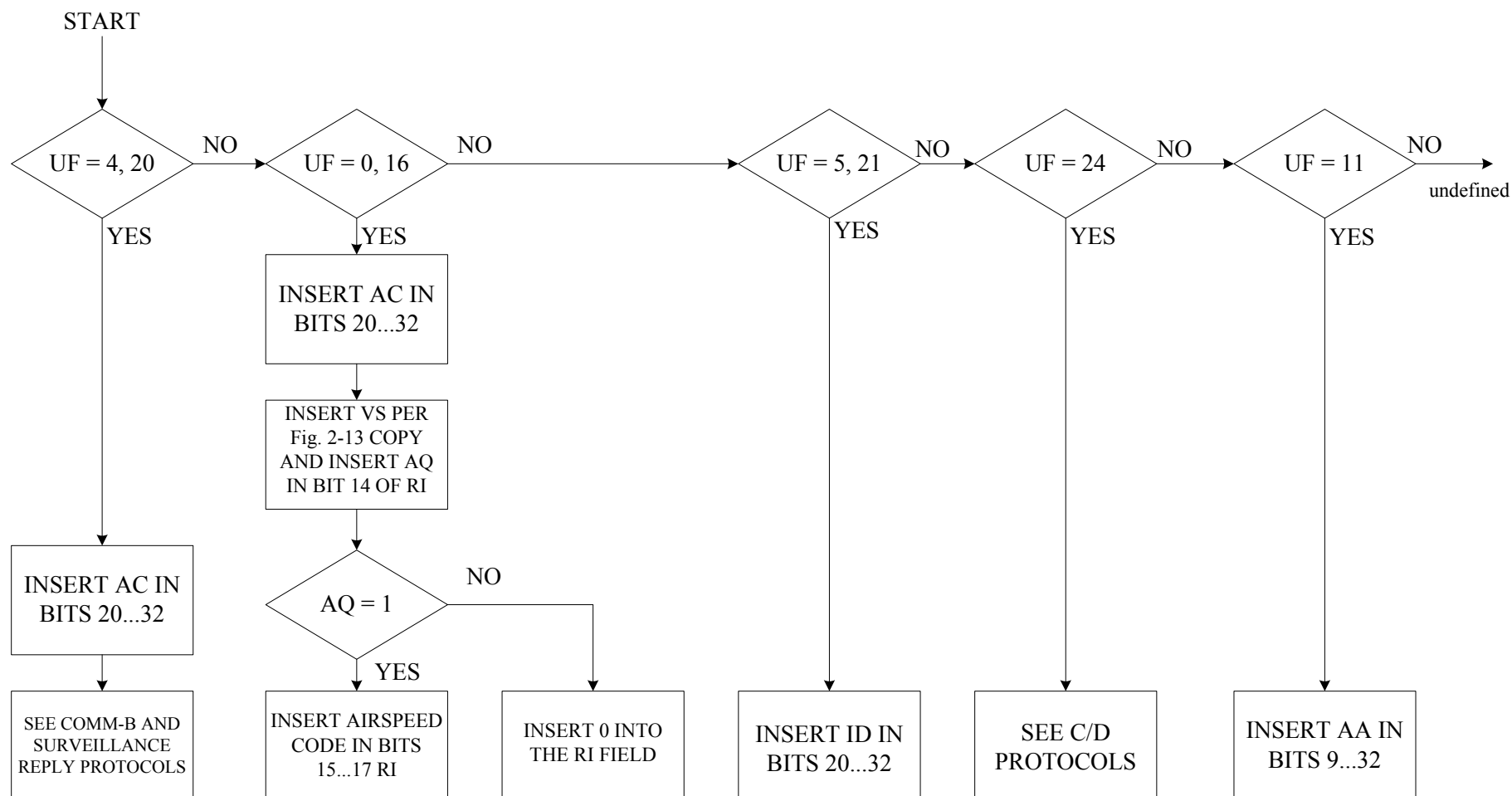


Figure 2-14R1: WITH CHANGES PROPOSED TO HARMONIZE WITH ED-73C Figure 3-13

Specific Details Regarding Differences in Figures (Continued):

8. Figure 2-16 in DO-181D differed from Figure 3-15 in ED-73C because it appears that Figure 3-15 had been updated to add the decision boxes for SI protocol and Figure 2-16 had not been updated. Figure 2-16R1 was presented during the Brussels meeting showing two “Option to Reply” decision boxes proposed to be added by Tom Pagano, and they are retained in the Figures below. Therefore Figure 2-16R1 is shown below as the “original,” and Figure 2-16R2 is shown below as modified to account for the addition of the diamonds for SI protocol.

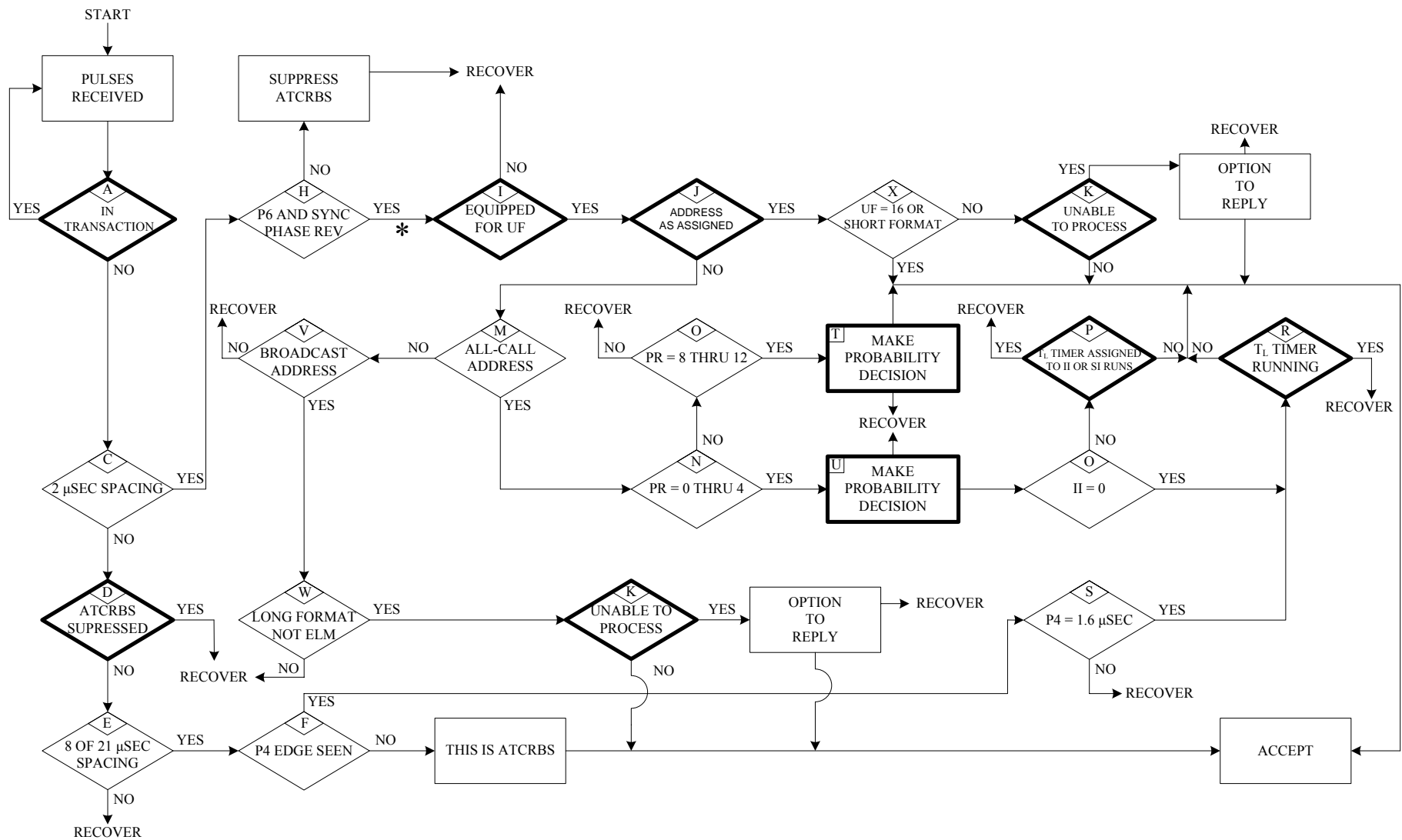


Figure 2-16R1: ORIGINAL FROM DO-181D, v1.1 in the Brussels Meeting

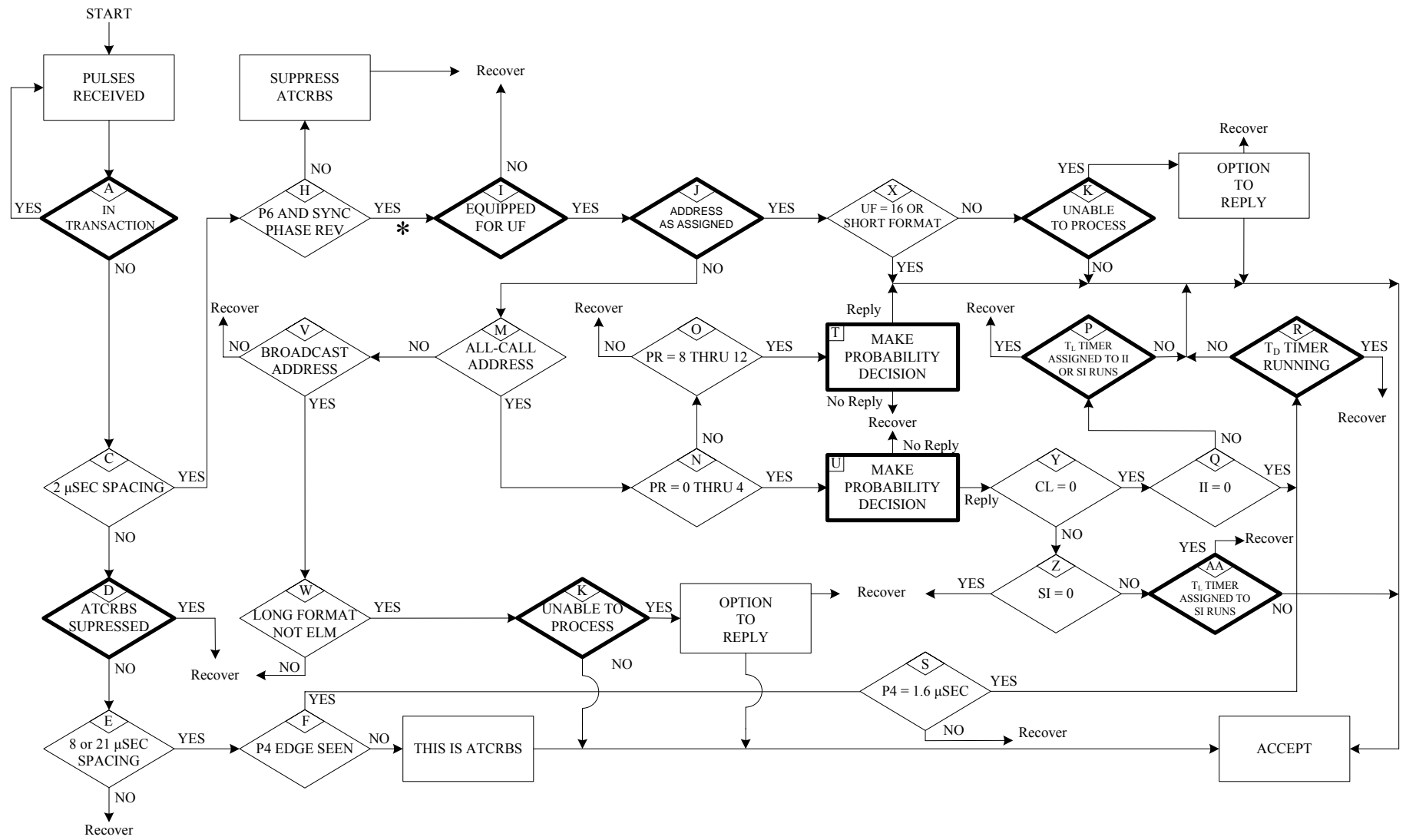


Figure 2-16R2: WITH CHANGES PROPOSED TO HARMONIZE WITH ED-73C Figure 3-15 with SI Protocol

Specific Details Regarding Differences in Figures (Continued):

9. Figure 3-17 in ED-73C has a decision diamond indicating that “ T_{RS} Timer Runs.” That is incorrect, and it should be “ T_{RB} Timer Runs” as in Figure 2-18 of DO-181D, shown below.

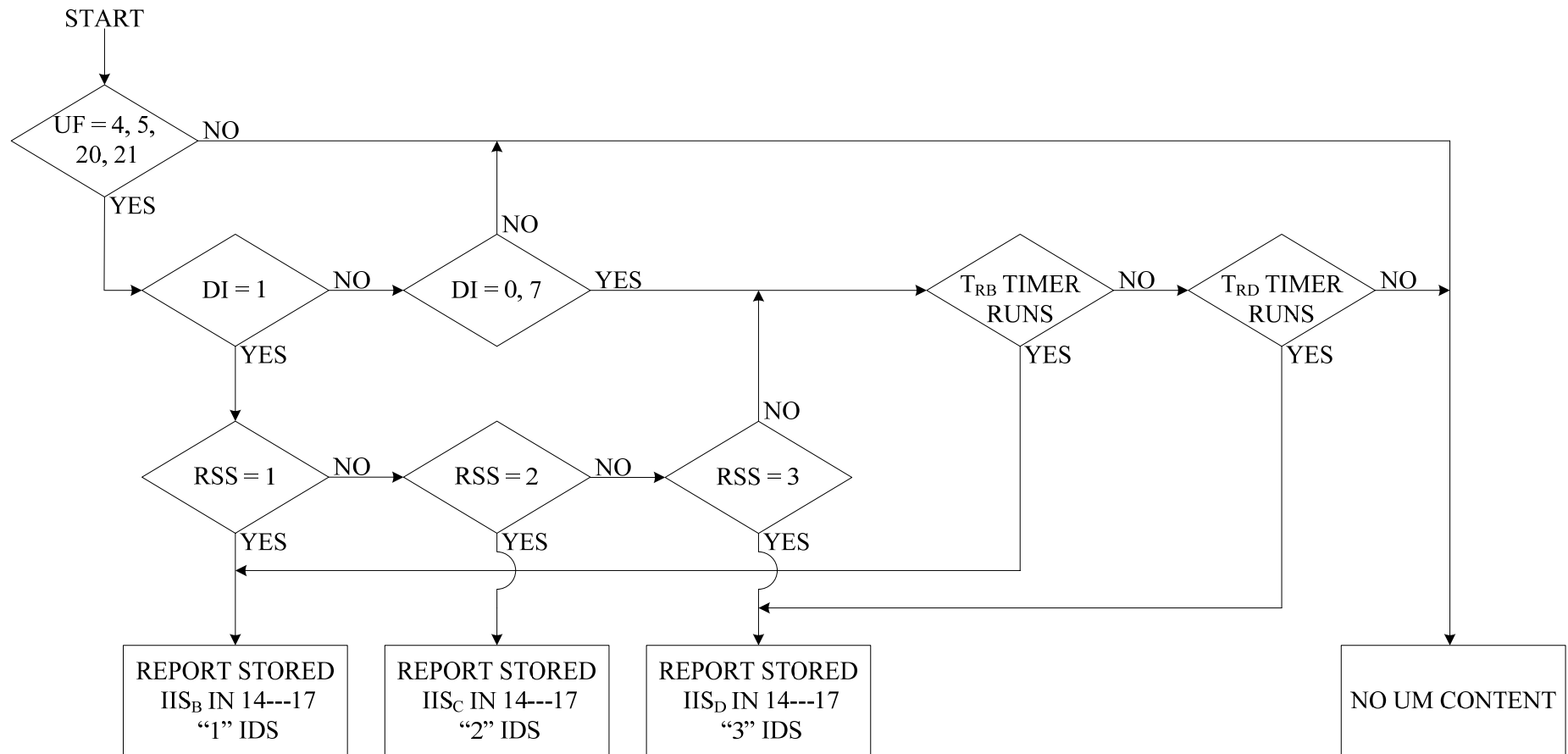


Figure 2-18: All Level 2 Transponders UM Protocol

10. Figure 2-19 in DO-181D and Figure 3-18 in ED-73C has been the topic of many separate discussions in previous meetings. Proposed changes were originally identified in Working Paper ModeS-WP01-06, with a corresponding change to the test procedure identified in Working Paper ModeS-WP01-05. The latest revision of the suggested changes are explained in detail in Working Paper ModeS-WP03-11. The version of Figure 2-19R1 shown below has been updated as per the changes in ModeS-WP03-11.

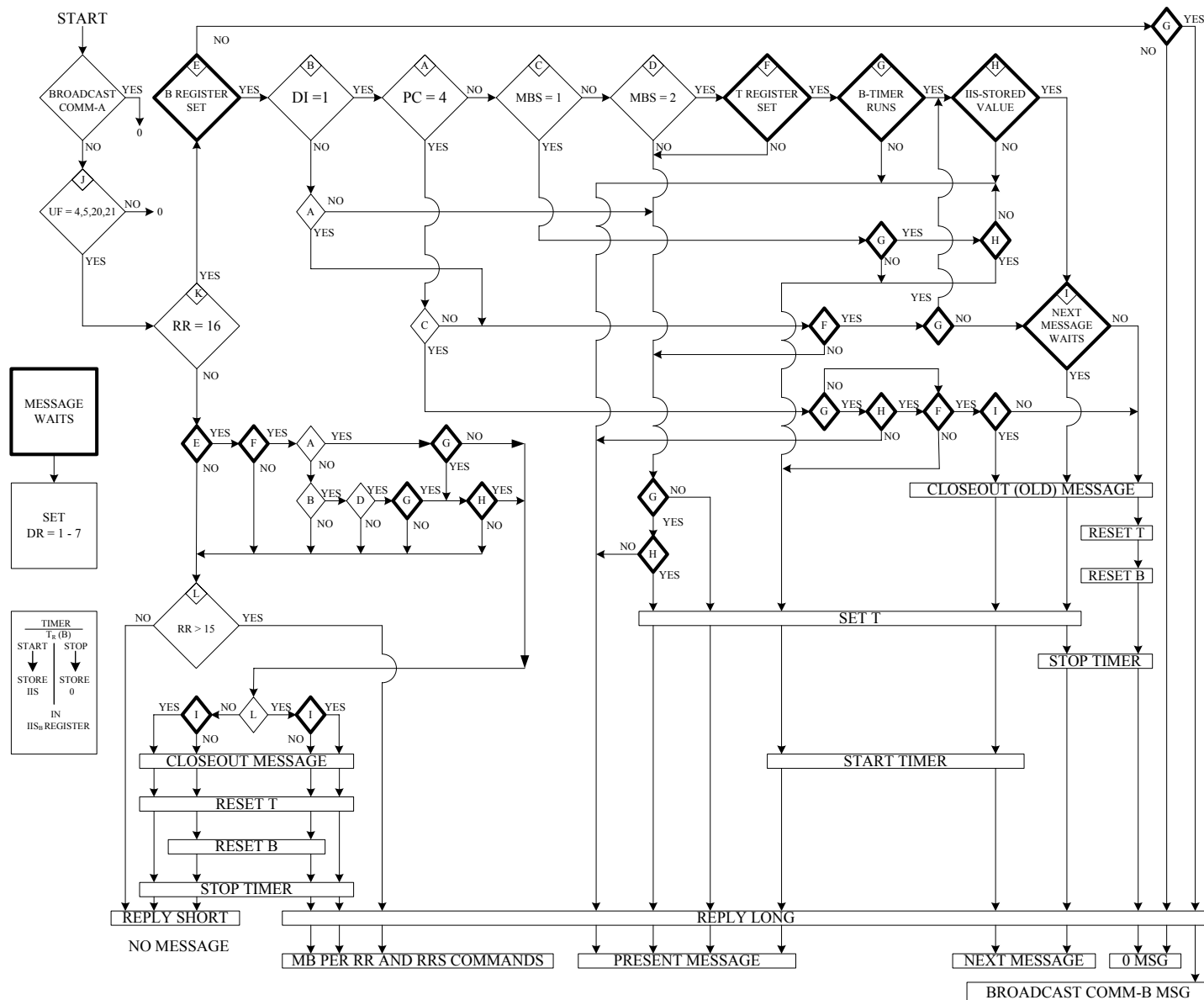


Figure 2-19R1: All Data Link Transponders B Protocol

11. A Visio version of ED-73B, Figure 3-18A – “Enhanced Comm-B Protocol” has been generated and it is suggested that it be inserted as-is into DO-181D in the appropriate location.
12. A Visio version of ED-73B, Figure 3-19A – “Enhanced Comm-C Reservation and Close Out” has been generated and it is suggested that it be inserted as-is into DO-181D in the appropriate location.

13. Figure 2-21 in DO-181D appears to have been updated at least once since Figure 3-20 in ED-73C was last updated, and we believe that Figure 2-21 is accurate, and represents the correct flow chart for Comm-C Message Handling. We recommend that Figure 3-20 in ED-73C be replaced with the current Figure 2-21 from the latest draft of DO-181D, as shown below.

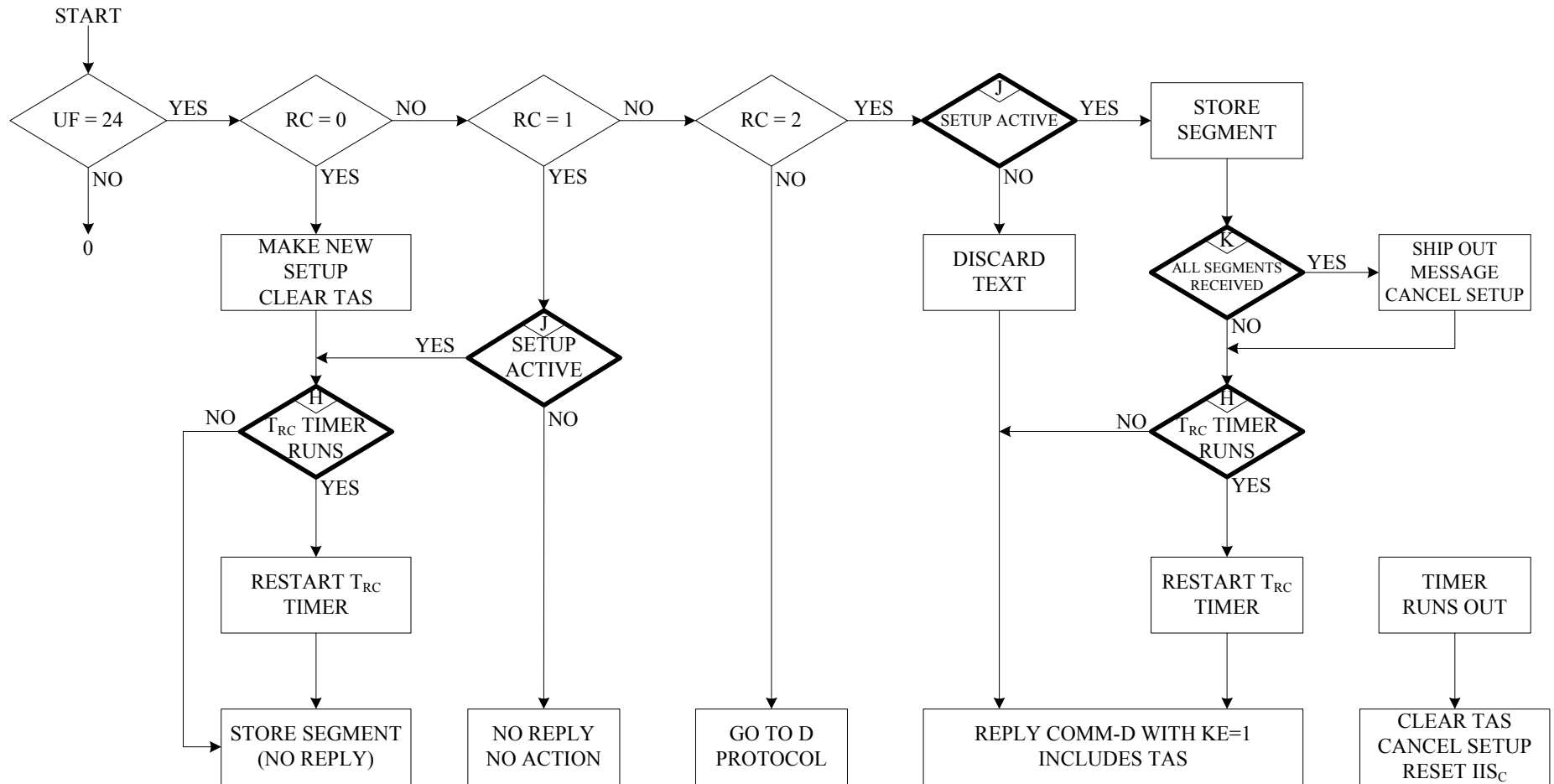


Figure 2-21: Comm-C Message Handling

14. ED-73C, Figure 3-20A for “Enhanced Comm-C Message Handling” should be based on the version of DO-181D, Figure 2-21 above. We propose that the Figure for “Enhanced Comm-C Message Handling” be accepted in both documents as the following:

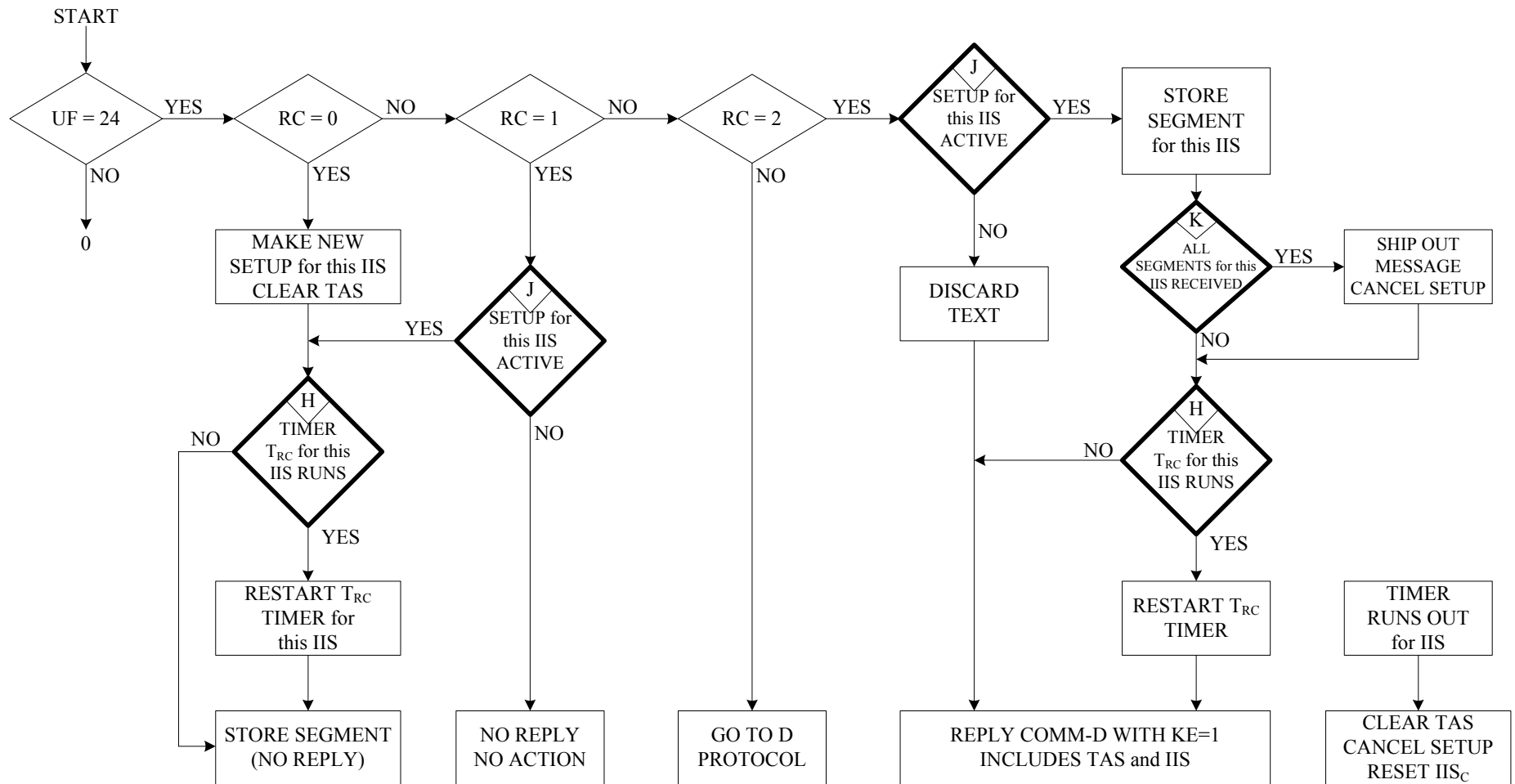


Figure 2-xx: Enhanced Comm-C Message Handling

15. A Visio version of ED-73B, Figure 3-21A – “Enhanced Comm-D Reservation and Close Out” has been generated and it is suggested that it be inserted as-is into DO-181D in the appropriate location.
16. Figure 3-22 in ED-73C has an error in the outputs of decision box “E” where the “YES” and “NO” are reversed. This is correct in Figure 2-23 in DO-181D. However, there is different error in Figure 2-23 in that whenever the T_{RD} Timer runs out, the “D” Register should NOT be cleared as shown in the bottom box under the “Non-Synchronous” boxes on the extreme right of the figure below. The original DO-181C, Figure 2-23, and the proposed revised Figure 2-23R1 for DO-181D appear below.

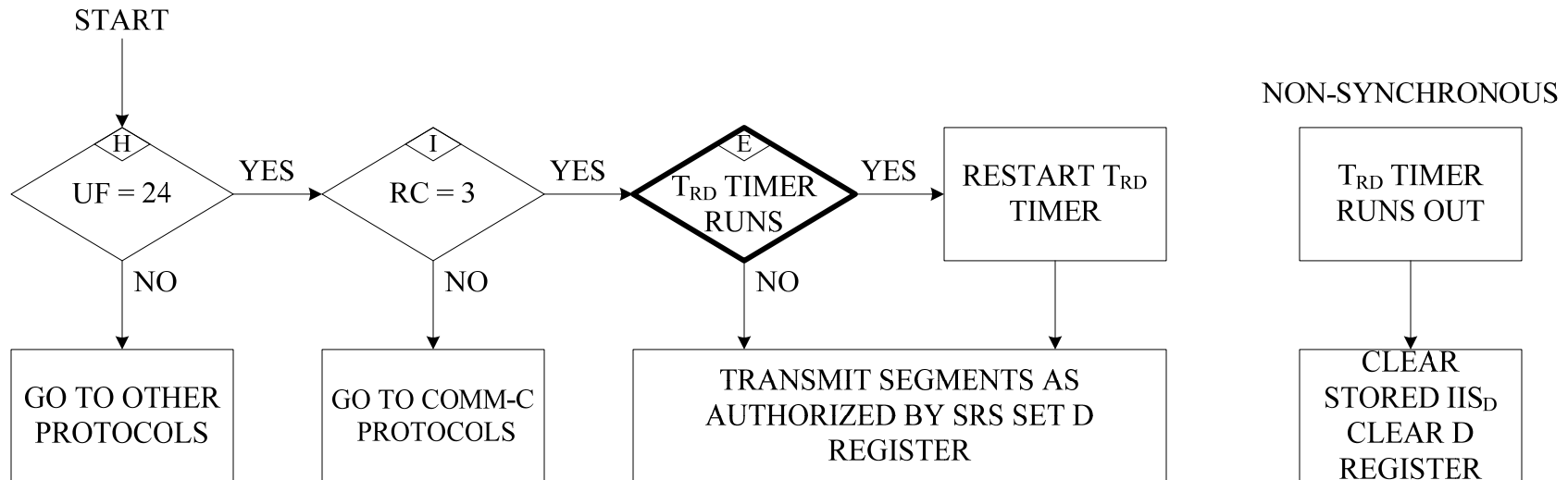


Figure 2-23: ORIGINAL FROM DO-181D, v1.1 in the Brussels Meeting

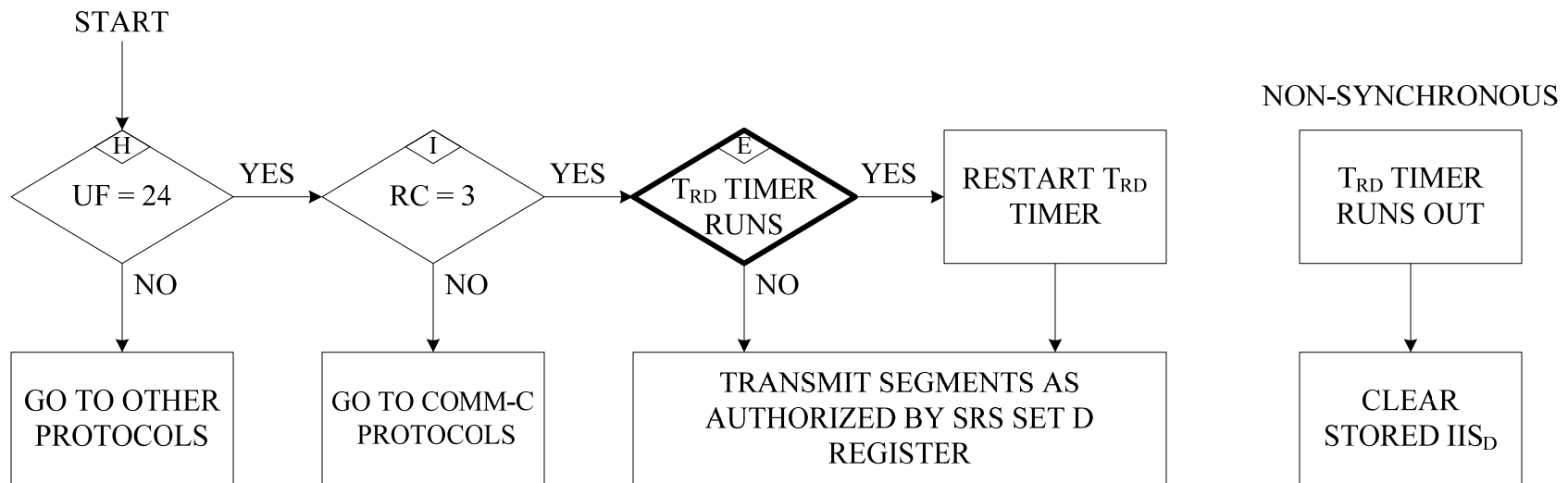


Figure 2-23R1: WITH CHANGES PROPOSED TO HARMONIZE WITH ED-73C Figure 3-22

17. Figure 3-22A in ED-73C contains the same error in the outputs of decision box “E” where the “YES” and “NO” are reversed. With this error corrected, we proposed that the figure below be accepted and placed into both documents in the appropriate places.

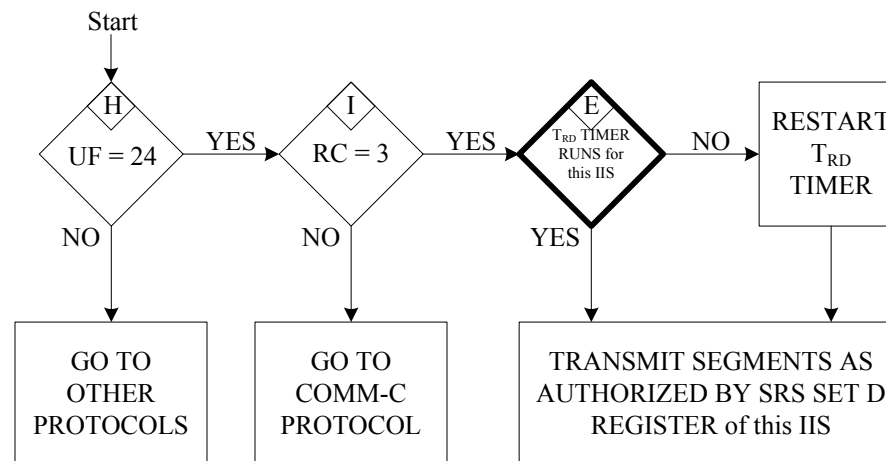


Figure 2-xx: Enhanced Comm-D Message Handling